July 2008

NorthWestern Energy

Mountain States Transmission Intertie

ENVIRONMENTAL REPORT

GEOLOGY AND SOILS TECHNICAL REPORT

PROJECT NUMBER:
112100

PROJECT CONTACT:
ANDY MORK
EMAIL:
ANDY.MORK@POWERENG.COM
PHONE:
208 685-6462

POWER ENGINEERS

TABLE OF CONTENTS

1.0 INTRODUCTION 1

1.1 PROJECT OVERVIEW 1
1.1.1 New 500kV Transmission Line 1
1.1.2 New Townsend Substation 3
1.1.3 Mill Creek Substation 3
1.1.4 Midpoint Substation Modifications 3

1.2 GEOLOGY AND SOILS OVERVIEW 3
1.2.1 Resource Issues 4
1.2.2 Study Personnel 5

2.0 REGULATORY FRAMEWORK 6

3.0 INVENTORY METHODS 7

3.1 GEOLOGY 7
3.1.1 Data Categories 7
3.1.2 Field Verification 8

3.2 SOILS 8
3.2.1 Data Categories 8
3.2.2 Field Verification 10

4.0 INVENTORY RESULTS 11

4.1 GEOLOGY 11
4.1.1 Montana Geology Summary 11
4.1.2 Idaho Geology Summary 11

4.2 SOILS 13
4.2.1 Montana Soils Summary 14
4.2.2 Idaho Soils Summary 17

5.0 IMPACT METHODS 20

5.1 RESOURCE SENSITIVITY 21

5.2 IMPACT LEVELS 21
5.2.1 Geology 21
5.2.2 Soils 23

6.0 IMPACT RESULTS 26

6.1 GEOLOGY 26

6.2 SOILS 26

7.0 REFERENCES..28

List of Figures

Figure 1.1-1 Project Area and Alternative Transmission Line Routes............................ 2

List of Tables

Table 4.1-1 Geologic Hazards and Reclamation Constraints in Montana............... 12
Table 4.1-2 Geologic Hazards and Reclamation Constraints in Idaho.................... 13
Table 4.2-1 Soil Factors in Montana 14
Table 4.2.2 Soil Factors in Idaho 19

APPENDICES

APPENDIX A

Table A-1 Geologic Inventory Results
Table A-2A Soil Resilience Rating
Table A-2B Water Erosion Rating
Table A-2C Wind Erodibility Group Ratings
Table A-3 Geologic Hazards Result Summary
Table A-4 Soil Results Summary

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

NorthWestern Energy (NorthWestern) proposes to construct, operate and maintain the MSTI 500kV transmission line to address the requests for transmission service from customers and relieve constraints on the high-voltage transmission system in the region. The new transmission line would begin at Townsend Substation which would be constructed in southwestern Montana about five miles south of Townsend, Montana, east of U.S. Highway 287 (US 287) in Broadwater County. The line would proceed south into southeastern Idaho connecting to Idaho Power Company's (IPCO) existing Midpoint Substation, 12 miles northeast of Jerome, Idaho. Figure 1.1-1 shows the substation locations and the alternative routes being considered.

The major projects components of the proposed action include the 500kV alternating current (AC) transmission line, a new Townsend Substation; construction of a new facility next to the existing Mill Creek Substation near Anaconda, Montana for the installation of a bank of phase shifting transformers and modifications to the existing Midpoint Substation in Idaho. Brief descriptions of the major project components are presented in the following sections.

1.1.1 NEW 500KV TRANSMISSION LINE

The MSTI 500kV AC transmission line would interconnect the new Townsend Substation with IPCO's existing Midpoint Substation. The MSTI 500kV transmission line would be between 400 and 430 miles long.

Various alternative route links have been identified as part of the siting study for the transmission line. During the route selection process, some of these alternative route links were combined into a limited number of end-to-end route and subroute alternatives. A preferred route was selected based on environmental and other considerations. Alternative route links, shown in Figure 1.1-1, cross Silver Bow, Jefferson, Broadwater, Deer Lodge, Beaverhead, and Madison counties in southwestern Montana, and Clark, Jefferson, Blaine, Butte, Bingham, Bonneville Power, Minidoka, Lincoln, and Jerome counties in southeastern Idaho. The links cross private, state (Idaho and Montana) and federal (primarily Bureau of Land Management [BLM] and U.S Forest Service [USFS]) land. There are a total of 1,150 miles of alternative route links, 582 miles in Montana and 568 miles in Idaho.

The MSTI 500kV transmission would be constructed mainly on guyed V steel lattice structures approximately 125 feet high. Less frequently, self-supporting steel lattice structures or self-supporting tubular steel structures approximately 125 feet high would be used. The guyed V structure would be used for most tangent segments of the line. Self-supporting steel lattice structures would be used in mountainous areas and at points where a line changes direction or terminates. Tubular steel monopoles may be used in areas of narrow right-of-way or where permanent land disturbance or the amount of land required for the structure must be minimized (e.g., agricultural land, developed and urban land, and some river and perennial stream crossings). The land permanently required for the structures would vary depending on structure type and terrain, ranging from 100 square feet for steel

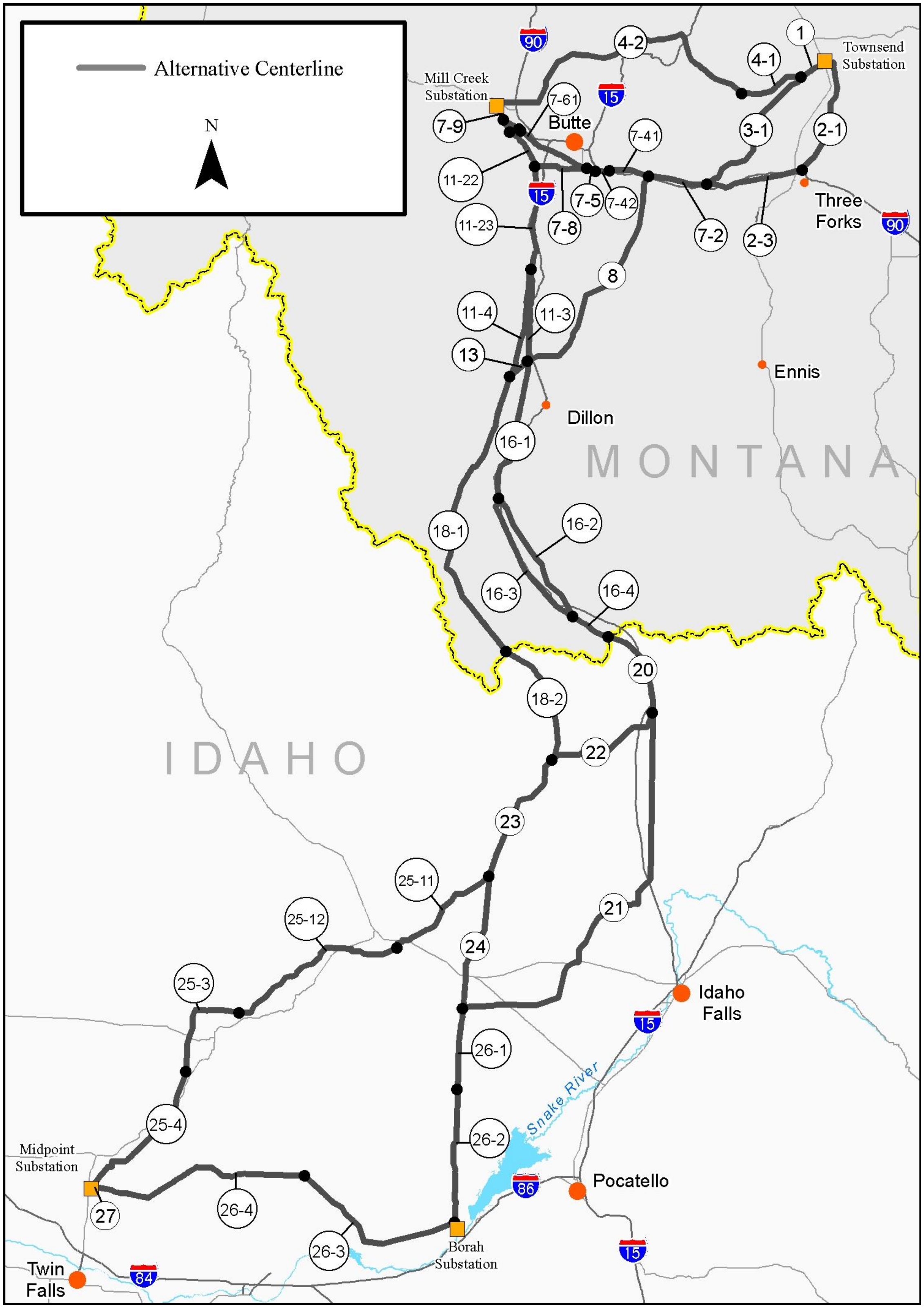

Figure 1.1-1 Project Area and Alternative Transmission Line Routes

monopoles to 22,500 square feet for the guyed V structures. An area of approximately 200 by 200 feet (0.9 acre) per structure may be temporarily disturbed during construction.

The required right-of-way width is 220 feet and the average span length between the transmission structures would be approximately 1,400 feet (4 per mile) for the guyed V structures, 1,200 feet (4 per mile) for the self-supporting steel lattice structures, and 900 feet (6 per mile) for the self-supporting tubular steel monopole structures.

Access along the transmission line right-of-way would include using existing improved roads, using existing roads that require improvement, and building new roads in flat, sloping, steep, or very steep terrain. Permanent new roads would be graded to a travel service width of 14 feet.

In addition, during construction of the transmission line there would be temporary pulling and tensioning sites, material staging sites, and concrete batch plants.

1.1.2 NEW TOWNSEND SUBSTATION

The new Townsend 500kV substation would be located in southwestern Montana, five miles south of Townsend, Montana, east of US 287 in Broadwater County, Montana. The current land use of the site is center-pivot irrigation. The parcel contains agricultural outbuildings and a residence, located about 1,030-feet south of the substation site. Adjacent land use is a mixture of center-pivot irrigation and pasture. The total size of the Townsend Substation site would be approximately 52 acres

1.1.3 MILL CREEK SUBSTATION

A new facility would be built adjacent to NorthWestern's existing Mill Creek Substation, located approximately three miles south of Anaconda, Montana. The proposed facility would be built to accommodate a bank of phase shifting transformers and other series capacitor banks and associated substation equipment. The MSTI 500kV line would not connect directly to or require modification of the existing substation. Engineering studies will be completed to determine the final layout of this new facility.

1.1.4 MIDPOINT SUBSTATION MODIFICATIONS

IPCO's existing Midpoint Substation located 10 miles north of Interstate 84 (I-84) in Jerome County, Idaho would be modified to accommodate the new MSTI 500kV transmission line. Engineering studies with IPCO will be completed to determine the ultimate modifications required at the Midpoint substation.

1.2 GEOLOGY AND SOILS OVERVIEW

The MSTI project area is divided at the northern margin of the Snake River Plain into two physiographic provinces. The northern portion of the project is located in the Northern Rocky Mountain physiographic province, and the southern portion is located in the Snake River Plain physiographic province. There is a striking contrast in the geology and landforms between the two provinces.

The Northern Rocky Mountain Province is characterized by tall mountains and broad valleys. The mountains consist of a wide variety of sedimentary, metamorphic and igneous rocks ranging from Archean gneiss greater than 2.5 billion years old to Eocene volcanics approximately 40 million years old. The valleys are generally filled with young sedimentary material eroded from the emergent mountain peaks. In places the sedimentary valley-fill deposits extend more than 10,000 feet below the ground surface.

The eastern Snake River Plain province is characterized as a nearly level volcanic plain. The rocks underlying the surface are generally composed of rhyolite, with minor basalt flows emplaced within the uppermost part of the thick rhyolite sequence.

In between the basalt outcrops, the surface of the Plain is covered with unconsolidated deposits including sand dune fields, shallow dry lake beds, stream deposits and loess.

Several areas of very young basalt occur in this area, including the black lava flows at Craters of the Moon National Monument. The youngest of these basalt flows is estimated to be about 2,000 years old.

The project area is in the proximity of several active fault zones (USGS, 2008). Active faults are defined as those that have had significant movement in the Quaternary period (the last 1.6 million years). The faults mapped in the southwestern Montana and eastern Idaho region generally occur in northwest to southeast trending zones. The zones may be comprised of several individual fault strands that are similar in sense of motion and age of activity. Analysis of movement on most of the recent faults suggested this region is undergoing tectonic extension. This type of faulting results in the relative uplift of the mountain ranges in comparison to adjacent valley floors. The locations of the active faults are tabulated in Section 4.1.1.

Soil development is reflective of source material, climate, and duration of weathering. In general, the soils in the MSTI project area are divided into two groups: (1) a northern group occurring north of the Snake River Plain; and (2) a southern group occurring within the Snake River Plain. Soils within the northern group are derived from relatively local sources, for example bedrock or alluvial deposits. Soils within the Snake River Plain are largely derived from weathering of wind-blown loess originating close to the retreating ice front far to the north and deposited during the close of the last Ice Age, approximately 10,000 years before present. The arid Snake River Plain also is host to numerous large dune fields. The dunes are composed entirely of cohesionless fine to medium sand that actively migrates along with the prevailing wind direction.

1.2.1 RESOURCE ISSUES

The evaluation of earth resources along the MSTI alternative route links is intended to provide technical information to identify and assess risks of geologic and soil erosion hazards and reclamation constraints. This analysis does not assess mineral and non-mineral resources within the study area.

Specific requirements for earth resource assessments per Circular MFSA-2 include:

- Identification of highly erodible soils and areas with severe reclamation constraints, defined as soils developed on Cretaceous shales, intrusives and certain lacustrine deposits (Section 3.4 1(k));

- Identification of wind and water erosion risks (Section 3.7 8(a));
- Identification of mass movement potential (Section 3.7 8(b)); and
- Identification of constraints to reclamation and revegetation potential (Section 3.7 8(c)).

In addition to these issues, specific segment lengths within alternative route links with risk associated with active faults, soil liquefaction, and unique geologic features were identified.

Unlike many resources that may potentially be impacted by the MSTI project, the assessment of earth resources has a two-fold objective: (1) evaluate potential risk the project may have on existing resources (as with other resources); and (2) evaluate earth conditions that may impose risk on project infrastructure integrity and function.

1.2.2 STUDY PERSONNEL

Geologic data was obtained from three sources: (1) electronic databases; (2) published paper geologic maps; and (3) interviews. Greg Schlenker of Kleinfelder, Inc. assembled the geology database from electronic and paper source maps. Tim Hazekamp of POWER Engineers, Inc. (POWER) constructed the geology geographic information system (GIS) coverage and augmented the geologic mapping data provided by Mr. Schlenker. Andy Mork of POWER interviewed knowledgeable staff including Jeff Lonn and Susan Vuke from the Montana Bureau of Mines and Geology (MBMG) and Virginia Gillerman of the Idaho Geologic Survey (IGS). Andy Mork performed data analysis and prepared the text of this chapter.

The soil data was compiled from the web-based National Resource Conservation Service (NRCS) Soil Data Mart by Steven Caruana of Kleinfelder, Inc. Due to the length of this project, data was obtained at the soil association level, excluding the detail inherent with soil group data. The level of data analyzed in this report will be sufficient to meet the resource assessment objective. Tim Hazekamp of POWER constructed the soil GIS coverage and augmented the soil data provided by Mr. Caruana. Andy Mork of POWER interviewed knowledgeable staff including David Hoover of the Boise Regional Office of the NRCS, performed data analysis and prepared the text of this chapter.

2.0 REGULATORY FRAMEWORK

The alignment crosses federal, Montana and Idaho state lands and private lands. There are few regulatory requirements for earth resource assessments across federal lands, and none for state lands within Idaho. Federal agency Resource Management Plans (RMPs) and Forest Management Plans have provisions for mining; and locatable, leasable and saleable minerals; and for land use issues. However, the RMPs and Forest Plans have no specific provisions for geology and soils, with one exception. The exception is the RMP prepared for the Craters of the Moon National Monument and Preserve (BLM 2007). This RMP includes the Great Rift National Natural Landmark. The RMP defines four Management Actions related to the unique and fragile natural setting. The four management actions are:

- NRES-1: Resource inventories, surveys and monitoring programs will be provided for and implemented.
- GEOL-3: Threats to outstanding examples of geologic features, including paleontological and cave resources, will be indentified and mitigated as appropriate.
- GEOL-4: Prior to authorizing surface-disturbing activities, areas will be surveyed for unique, rare or special geological resources including fossils.
- SOIL-2: The potential for, or presence, extent and condition of, biological soil crusts will be investigated to provide specific management guidance.

In Montana, transmission lines are subject to the provisions of Montana Department of Environmental Quality (MDEQ) Circular MFSA-2, Application Requirements for Linear Facilities (MDEQ 2004). Although Circular MFSA-2 only applies to applications within the state of Montana, the data for the Idaho portion of the project was presented in the same MFSA format to facilitate report preparation and agency review.

3.0 INVENTORY METHODS

3.1 GEOLOGY

The objectives of this evaluation are to: (1) summarize the bedrock and surficial geologic units within the study corridors; (2) identify geologic hazards that could pose a risk to the transmission line; and (3) identify potential impacts that transmission line construction, operation and maintenance may have on these resources. The study corridor for both geologic and soil resources was limited to one mile on either side of the transmission line centerline, resulting in a two-mile wide corridor along each alternative route link.

The geologic inventory process presents an overview of the regional geology and the specific geologic formations and features occurring within the study corridor. Information for the inventory was obtained primarily from the MBMG and IGS electronic data files, published paper maps, and interviews with MBMG and IGS staff. A compete list of information sources is presented in the reference section for this chapter, and includes:

- Montana Bureau of Mines and Geology
- Idaho Geologic Society
- U.S. Geological Survey (USGS) Quaternary Fault and Fold Database

Geologic units underlying the proposed project were identified using GIS data compiled from geologic maps prepared by the USGS, MBMG, and IGS. Geologic maps used to identify the geologic units intersected by the proposed project are in Section 7.0, References.

3.1.1 DATA CATEGORIES

Data collected from geologic maps of areas within the study corridors includes:

- Formation names and rock types,
- Active faults, and
- Mapped landslides and avalanche debris.

A description of the rock types and total mileage of each rock type is summarized for each alternative route link. In addition, potential geologic hazards including mapped landslides (as per Circular MFSA-2, Section 3.7 (8)(b)), areas of potential liquefaction risk, and active faults are called out for each segment. Each of these features could pose a risk to the integrity of a transmission line. Ground failure due to any of these mechanisms may lead to support tower subsidence, listing, or collapse, and could have short- to long-term impacts to transmission line service.

Geohazard risks (i.e., landslides, liquefaction, and active faults) are denoted in Table A-1, Geologic Inventory Results (see Appendix A) by milepost and by the total mileage within each alternative route link. The mileage increments listed in the table identify the occurrence of each of the hazards.

To compile Table A-1 landslide locations were transcribed directly from the geologic maps. In this report, geologic units considered at risk for liquefaction include alluvial floodplains. Liquefaction is the condition in which unconsolidated, saturated strata lose bearing strength when agitated by forces such as seismic events. Liquefaction-prone areas were not specifically identified on the referenced maps, so the locations of liquefiable soils were instead inferred from soil texture and proximity to a shallow water table in an alluvial floodplain setting. Active faults were identified from the USGS Quaternary Fault and Folds database. Only those known or mapped faults that show geologic evidence of having been the source of large-magnitude, surface-deforming earthquakes (M > 6) during the Quaternary (since 1.6 million years ago (Ma)) are included.

In addition to landslides, areas of potential liquefaction risk, and active faults, Circular MFSA-2 requires identification of areas of ". . . severe reclamation constraints, defined as soils developed on Cretaceous shales, intrusives and certain lacustrine deposits…" (Circular MFSA-2 Section 3.4 (k)). As a means of explanation:

- Cretaceous shales are those shales deposited in the Cretaceous period approximately 145 to 65 Ma;
- Intrusives are igneous rocks that crystallized (i.e., formed a solid mass) below the earth's surface. A common example of an intrusive rock is granite;
- Lacustrine deposits are sediments deposited in lakes. The lakes can be either freshwater or saline (playa) lakes. Playa lake deposits pose a challenge to reclamation because the high percentage of salts in the sediments limits plant growth. There are no lacustrine deposits located in the MSTI study area within Montana.

The milepost-by-milepost occurrence of Cretaceous shales, intrusives and lacustrine deposits is also included in Table A-1 in Appendix A.

3.1.2 FIELD VERIFICATION

No field verification was performed to corroborate the geologic map sources with respect to formation locations or lithologies. The interpretations of this study were based solely on review of the readily available sources cited in the reference section (Section 7.0).

3.2 SOILS

Soil data was obtained from the NRCS Soil Data Mart and compiled in a GIS. The data comes from the State Soil Geographic (STATSGO) database. Selected soil attributes identified for evaluation in this report included erosion by wind and water, and reclamation and revegetation potential. These attributes are summarized in Tables A-2a through A-2c in Appendix A.

3.2.1 DATA CATEGORIES

Soil factors used to perform this assessment included T Factor for reclamation and revegetation potential, water erosion potential (Kw), and wind erodibility group (WEG).

3.2.1.1 T Factor – Soil Erosion Factor

T is an estimate of the average annual rate of soil erosion by wind and water that can occur without affecting crop productivity over a sustained period. The STATSGO data range from 1 to 5, with soil category 1 being the least resilient and category 5 the most resilient. For the purposes of this study, the T Factor data were subjectively assigned these relative descriptors:

T Factor	Relative Descriptor
1	Least Resilient
2	Less Resilient
3	Moderately Resilient
4	Somewhat Resilient
5	Most Resilient

3.2.1.2 Kw – Erosion factor

Kw indicates the susceptibility of a soil to sheet or rill erosion. Factor K is one of the several factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average rate of soil loss by sheet or rill erosion in tons per acre per year. The estimates are based primarily on the percentage of silt, sand and organic matter, and on soil structure and permeability. The entire range for Kw values is from 0.02 to 0.69. The highest value noted for soils in this study was 0.49. In general, the higher the value, the more susceptible the soil is to sheet and rill erosion by water. Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments. For the purposes of this study the Kw data were subjectively assigned these relative descriptors:

Kw	Relative Descriptor
0.37-0.69	Most Susceptible
0.20-0.32	Moderately Susceptible
0.10-0.17	Least Susceptible

3.2.1.3 WEG – Wind Erodability Group

The WEG groups are comprised of soils having similar properties affecting their susceptibility to wind erosion in cultivated areas. Wind erodibility index is a numerical value indicating the susceptibility of a soil to wind erosion, or tons of soil per acre per year that can be expected to be lost to wind erosion. The WEG groups range from 1 to 8. Soils assigned to Group 1 are the most susceptible to wind erosion, and those assigned to Group 8 are the least susceptible to wind erosion. There is a close correlation between wind erosion and surface layer texture, the size and durability of surface clods, rock fragments, organic matter and calcareous cements. Soil moisture and frozen soil layers also influence wind erosion. For the purposes of this study the WEG data were subjectively assigned these relative descriptors:

WEG	Relative Descriptor
1-2	Most Susceptible
3-6	Moderately Susceptible
7-8	Least Susceptible

3.2.2 FIELD VERIFICATION

No field verification was performed to corroborate the soil data sources with respect to field occurrences. The interpretations of this study were based solely on review of the readily available sources cited in the reference section (Section 7.0).

4.0 INVENTORY RESULTS

4.1 GEOLOGY

This section summarizes the geologic hazards and constraints within the study corridors. The milepost-by-milepost description of geology, geologic hazards and reclamation constraints is summarized in Appendix A, Table A-1. Tables 4.1-1 and 4.1-2 divide the study area into 46 alternate route links; 28 of which are located in Montana. The links located in Montana are numbered 1 through 18-1; the remainder describes geology of the study area segments located in Idaho.

Sensitivity ratings are assigned to the cumulative sensitivity of each alternative route link to initial unmitigated geologic hazards, reclamation constraints, or in Idaho, location within either the Craters of the Moon National Monument or Great Rift National Natural Landmark. The initial sensitivity for all geologic hazards is high because unmitigated hazards or reclamation constraints have a generally high risk to the project infrastructure integrity and function. A more comprehensive discussion of sensitivity and impacts is presented in Section 5.0.

4.1.1 MONTANA GEOLOGY SUMMARY

Table 4.1-1 is a link-by-link summary of geologic hazards and reclamation constraints occurring in the alternative route links located in Montana, Links 1 through 18-1.

4.1.2 IDAHO GEOLOGY SUMMARY

Table 4.1-2 is a link-by-link summary from Appendix A, Table A1 of geologic hazards and reclamation constraints occurring in the alternative route links located in Idaho, Links 18-2 through 31.

Three of the alternate route links in Idaho traverse either or both Craters of the Moon National Monument or Great Rift National Natural Landmark. These links are 26-3, 30 and 31. These are designated as areas of initial high sensitivity due the potential presence of unique geologic features such as ice caves, fissures, mineral-lined cavities, rift zones and other volcanic phenomena.

Table 4.1-1 Geologic Hazards and Reclamation Constraints in Montana

Link No.	Geologic Hazards	Reclamation Constraints	Sensitivity
1	None	None	Low
2-1	Liquefaction	Intrusives	High
2-2	Liquefaction	None	High
2-3	Liquefaction	None	High
3-1	Liquefaction Landslides	Intrusives	High
3-2	None	None	Low
4-1	Liquefaction	Intrusives Cretaceous shale	High
4-2	None	Intrusives	High
4-3	Liquefaction Active Faults	Intrusives	High
7-1	Liquefaction	None	High
7-2	Liquefaction	None	High
7-3	None	Intrusives	High
7-41	None	Intrusives	High
7-42	Liquefaction	Intrusives	High
7-43	None	None	Low
7-5	None	None	Low
7-61	Liquefaction Active Faults	Intrusives	High
7-62	None	None	Low
7-63	None	None	Low
7-71	None	None	Low
7-72	None	Intrusives	High
7-8	Liquefaction Active Faults	Intrusives	High
7-9	None	None	Low
8	Liquefaction Active Faults	Intrusives Cretaceous shale	High
11-21	None	Intrusives	High
11-22	Liquefaction	None	High
11-23	Liquefaction	None	High
11-3	Liquefaction	None	High
11-4	Liquefaction	Cretaceous shale	High
13	Liquefaction	Cretaceous shale	High
16	Liquefaction	None	High
18-1	Liquefaction Active Faults Landslides	None	High

Table 4.1-2 Geologic Hazards and Reclamation Constraints in Idaho

Link No.	Geologic Hazards	Reclamation Constraints	Nat'l Landmark/ Nat'l Monument	Sensitivity
18-2	Active faults Landslides	None	No	High
20	Liquefaction	None	No	High
21	Liquefaction Active Faults	Intrusives Lacustrine	No	High
22	Liquefaction	None	No	High
23	Liquefaction Active Faults	Lacustrine	No	High
24	Liquefaction	Lacustrine	No	High
25-11	Liquefaction	Lacustrine	No	High
25-12	Liquefaction Active Faults	None	No	High
25-3	Liquefaction	None	No	High
25-4	None	None	No	Low
26-1	Liquefaction	Lacustrine	No	High
26-2	None	None	No	Low
26-3	None	None	Yes	High
26-4	None	Lacustrine	No	High
27	Liquefaction	Lacustrine	No	High
28	None	None	No	Low
30	None	None	Yes	High
31	Active faults	None	Yes	High

4.2 SOILS

This section summarizes the soil attributes for the alternate route links. The milepost-by-milepost description of soil factors T, Kw and WEG is summarized in Appendix A, Tables A-2a, A-2b and A-2c, respectively. As in the Geology description (Section 4.1), the Tables 4.2-1 and 4.2-2 divide the study area into 46 alternate route links; 28 of which are located in Montana. The links located in Montana are numbered 1 through 18-1; the remainder describes links located in Idaho.

Sensitivity ratings are assigned to the soils within each alternate route link based on the comparison of the soil factors T, Kw and WEG. The sensitivity of the link is determined by the occurrence of the least resilient/most susceptible soil characteristic according to the following scale:

- High Sensitivity Characteristics
  - T factors rated as Least or Less Resilient
  - Kw rated as Most Susceptible
  - WEG rated as Most Susceptible

- Moderate Sensitivity Characteristics
  - T factors rated as Moderately or Somewhat Resilient
  - Kw rated as Moderately Susceptible
  - WEG rated as Moderately Susceptible

- Low Sensitivity Characteristics
  - T factors rated as Most Resilient
  - Kw rated as Least Susceptible
  - WEG rated as Least Susceptible

4.2.1 MONTANA SOILS SUMMARY

The following is a link-by-link summary of soil factors occurring in the alternative route links located in Montana, links 1 through 18-1.

Table 4.2-1 Soil Factors in Montana

Link	Reveg/Reclam (T Factor)	Water Erosion (Kw)	Wind Erosion Group (WEG)	Sensitivity
1	Least Resilient: 3.2 Less Resilient: 0.0 Mod. Resilient: 0.3 Somewhat Res.: 0.0 Most Resilient: 3.6	No Data: 0.0 Most Suscept.: 1.1 Mod Suscept.: 5.7 Least Suscept.: 0.3	Most Suscept.: 0.0 Mod Suscept. 4.3 Least Suscept.: 2.8	High
2-1	Least Resilient: 16.4 Less Resilient: 0.0 Mod. Resilient: 2.8 Somewhat Res.: 0.0 Most Resilient: 6.6	No Data: 0.0 Most Suscept.: 6.8 Mod Suscept.: 19.0 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 25.8 Least Suscept.: 0.0	High
2-3	Least Resilient: 0.5 Less Resilient: 0.0 Mod. Resilient: 3.0 Somewhat Res.: 0.0 Most Resilient: 17.0	No Data: 0.0 Most Suscept.: 17.4 Mod Suscept.: 2.2 Least Suscept.: 0.9	Most Suscept.: 0.0 Mod Suscept.: 15.4 Least Suscept.: 5.1	High
3-1	Least Resilient: 8.5 Less Resilient: 0.0 Mod. Resilient: 12.2 Somewhat Res.: 0.0 Most Resilient: 11.6	No Data: 0.0 Most Suscept.: 12.0 Mod Suscept.: 18.4 Least Suscept.: 1.9	Most Suscept.: 0.0 Mod Suscept.: 21.4 Least Suscept.: 10.9	High
4-1	Least Resilient: 8.0 Less Resilient: 0.0 Mod. Resilient: 4.8 Somewhat Res.: 0.0 Most Resilient: 0.7	No Data: 0.0 Most Suscept.: 0.9 Mod Suscept.: 8.0 Least Suscept.: 4.6	Most Suscept.: 0.0 Mod Suscept.: 0.2 Least Suscept.: 0.0	High
4-2	Least Resilient: 2.5 Less Resilient: 14.1 Mod. Resilient: 32.0 Somewhat Res.: 0.0 Most Resilient: 15.4	No Data: 0.0 Most Suscept.: 11.9 Mod Suscept.: 30.6 Least Suscept.: 21.5	Most Suscept.: 0.0 Mod Suscept.: 14.5 Least Suscept.: 49	High

Table 4.2-1 Soil Factors in Montana (*cont.*)

Link	Reveg/Reclam (T Factor)	Water Erosion (Kw)	Wind Erosion Group (WEG)	Sensitivity
7-2	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 0.2 Somewhat Res.: 0.0 Most Resilient: 12.0	No Data: 0.0 Most Suscept.: 12.1 Mod Suscept.: 0.1 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 9.0 Least Suscept.: 3.2	High
7-41	Least Resilient: 2.0 Less Resilient: 0.0 Mod. Resilient: 3.8 Somewhat Res.: 0.0 Most Resilient: 2.6	No Data: 0.0 Most Suscept.: 2.5 Mod Suscept.: 3.8 Least Suscept.:	Most Suscept.: 0.0 Mod Suscept.: 6.2 Least Suscept.: 2.2	High
7-42	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 2.0 Somewhat Res.: 0.0 Most Resilient: 1.0	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 1.1 Least Suscept.: 1.9	Most Suscept.: 0.0 Mod Suscept.: 3.0 Least Suscept.: 0.0	Moderate
7-5	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 0.9 Somewhat Res.: 0.9 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 0.9 Least Suscept.: 0.9	Most Suscept.: 0.0 Mod Suscept.: 0.8 Least Suscept.: 1.0	Moderate
7-61	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 6.4 Somewhat Res.: 4.3 Most Resilient: 5.3	No Data: 0.0 Most Suscept.: 5.4 Mod Suscept.: 6.3 Least Suscept.: 4.3	Most Suscept.: 0.0 Mod Suscept. 4.4 Least Suscept.: 11.6	High
7-62	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 0.4 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 0.4 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 0.4	Moderate
7-72	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 0.4 Somewhat Res.: 0.0 Most Resilient: 3.3	No Data: 0.0 Most Suscept.: 3.4 Mod Suscept.: 0.3 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 3.7	High
7-8	Least Resilient: 1.9 Less Resilient: 0.0 Mod. Resilient: 6.7 Somewhat Res.: 2.5 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 7.0 Mod Suscept.: 4.1 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 8.6 Least Suscept.: 2.5	High

Table 4.2-1 Soil Factors in Montana (*cont.*)

Link	Reveg/Reclam (T Factor)	Water Erosion (Kw)	Wind Erosion Group (WEG)	Sensitivity
7-9	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 2.1 Somewhat Res.: 0.0 Most Resilient: 1.1	No Data: 0.0 Most Suscept.: 1.4 Mod Suscept.: 1.8 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 3.2	High
8	Least Resilient: 1.3 Less Resilient: 0.0 Mod. Resilient: 38.5 Somewhat Res.: 0.0 Most Resilient: 10.5	No Data: 0.0 Most Suscept.: 21.0 Mod Suscept.: 28.2 Least Suscept.: 1.1	Most Suscept.: 0.0 Mod Suscept.: 33.0 Least Suscept.: 17.3	High
11-21	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 0.3 Somewhat Res.: 0.0 Most Resilient: 2.9	No Data: 0.0 Most Suscept.: 3.1 Mod Suscept.: 0.0 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 0.3 Least Suscept.: 2.9	High
11-22	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 4.9 Somewhat Res.: 0.0 Most Resilient: 4.0	No Data: 0.0 Most Suscept.: 0.7 Mod Suscept.: 4.9 Least Suscept.: 3.3	Most Suscept.: 0.0 Mod Suscept.: 8.3 Least Suscept.: 0.6	High
11-23	Least Resilient: 3.2 Less Resilient: 0.0 Mod. Resilient: 8.1 Somewhat Res.: 8.1 Most Resilient: 2.5	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 11.1 Least Suscept.: 10.8	Most Suscept.: 0.0 Mod Suscept.: 13.0 Least Suscept.: 8.9	High
11-3	Least Resilient: 0.6 Less Resilient: 0.0 Mod. Resilient: 18.6 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 15.1 Mod Suscept.: 3.6 Least Suscept.: 0.5	Most Suscept.: 0.0 Mod Suscept.: 15.6 Least Suscept.: 3.6	High
11-4	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 22.8 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 5.7 Mod Suscept.: 17.1 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 5.7 Least Suscept.: 17.1	High
13	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 4.9 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 0.7 Mod Suscept.: 4.2 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 0.7 Least Suscept.: 4.2	High

Table 4.2-1 Soil Factors in Montana (*cont.*)

Link	Reveg/Reclam (T Factor)	Water Erosion (Kw)	Wind Erosion Group (WEG)	Sensitivity
16-1	Least Resilient: 0.0 Less Resilient: 2.7 Mod. Resilient: 19.2 Somewhat Res.: 0.0 Most Resilient: 8.2	No Data: 0.0 Most Suscept.: 8.1 Mod Suscept.: 22.0 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 9.1 Least Suscept.: 21.0	High
16-2	Least Resilient: 0.0 Less Resilient: 3.7 Mod. Resilient: 9.0 Somewhat Res.: 0.0 Most Resilient: 16.6	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 29.3 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 17.4 Least Suscept.: 11.9	High
16-3	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 27.1 Somewhat Res.: 0.0 Most Resilient: 3.5	No Data: 0.0 Most Suscept.: 23.3 Mod Suscept.: 6.9 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 21.1 Least Suscept.: 9.5	High
16-4	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 8.7 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 8.7 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 0.0	High
18-1	Least Resilient: 0.0 Less Resilient: 6.5 Mod. Resilient: 50.1 Somewhat Res.: 0.0 Most Resilient: 6.9 No Data: 0.7	No Data: 0.7 Most Suscept.: 11.8 Mod Suscept.: 49.1 Least Suscept.: 2.3	Most Suscept.: 0.0 Mod Suscept.: 11.2 Least Suscept.: 53.0	High

4.2.2 IDAHO SOILS SUMMARY

Table 4.2-2 is a link-by-link summary of soils occurring in the alternative route links located in Idaho, Links 18-2 through 31.

Table 4.2-2 Soil Factors in Idaho

Link	Reveg/Reclam (T Factor)	Water Erosion (Kw)	Wind Erosion Group (WEG)	Sensitivity
18-2	Least Resilient: 0.0 Less Resilient: 10.5 Mod. Resilient: 0.8 Somewhat Res.: 0.0 Most Resilient: 15.7	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 15.9 Least Suscept.: 11.1	Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 27.0	High
20	Least Resilient: 0.0 Less Resilient: 4.0 Mod. Resilient: 0.1 Somewhat Res.: 0.0 Most Resilient: 15.9	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 18.8 Least Suscept.: 1.2	Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 20.0	High
21	Least Resilient: 0.0 Less Resilient: 25.0 Mod. Resilient: 0.0 Somewhat Res.: 0.0 Most Resilient: 64.4	No Data: 0.0 Most Suscept.: 48.6 Mod Suscept.: 23.5 Least Suscept.: 17.3	Most Suscept.: 11.4 Mod Suscept.: 62.5 Least Suscept.: 15.5	High
22	Least Resilient: 0.0 Less Resilient: 19.1 Mod. Resilient: 6.2 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 6.4 Mod Suscept.: 12.8 Least Suscept.: 6.1	Most Suscept.: 0.0 Mod Suscept.: 6.4 Least Suscept.: 18.9	High
23	Least Resilient: 28.7 Less Resilient: 0.0 Mod. Resilient: 0.3 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 0.4 Mod Suscept.: 0.0 Least Suscept.: 28.6	Most Suscept.: 0.0 Mod Suscept.: 0.4 Least Suscept.: 28.6	High
24	Least Resilient: 0.0 Less Resilient: 5.8 Mod. Resilient: 11.4 Somewhat Res.: 0.0 Most Resilient: 11.2	No Data: 0.0 Most Suscept.: 21.0 Mod Suscept.: 1.9 Least Suscept.: 5.5	Most Suscept.: 0.0 Mod Suscept.: 21.0 Least Suscept.: 7.4	High
25-11	Least Resilient: 10.3 Less Resilient: 4.7 Mod. Resilient: 10.9 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 12.2 Least Suscept.: 13.7	High
25-12	Least Resilient: 18.9 Less Resilient: 10.4 Mod. Resilient: 0.0 Somewhat Res.: 1.1 Most Resilient: 9.4	No Data: 0.0 Most Suscept.: 12.6 Mod Suscept.: 0.0 Least Suscept.: 13.3	Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 39.8	High

Table 4.2-2 Soil Factors in Idaho

Link	Reveg/Reclam (T Factor)	Water Erosion (Kw)	Wind Erosion Group (WEG)	Sensitivity
25-3	Least Resilient: 3.7 Less Resilient: 5.2 Mod. Resilient: 0.0 Somewhat Res.: 0.0 Most Resilient: 13.4	No Data: 0.0 Most Suscept.: 3.6 Mod Suscept.: 18.7 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 1.5 Least Suscept.: 20.8	High
25-4	Least Resilient: 11.9 Less Resilient: 0.3 Mod. Resilient: 21.5 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 6.1 Mod Suscept.: 11.8 Least Suscept.: 15.8	Most Suscept.: 16.3 Mod Suscept.: 5.5 Least Suscept.: 11.9	High
26-1	Least Resilient: 0.0 Less Resilient: 6.1 Mod. Resilient: 8.7 Somewhat Res.: 0.0 Most Resilient: 1.9	No Data: 0.0 Most Suscept.: 4.1 Mod Suscept.: 7.1 Least Suscept.: 5.5	Most Suscept.: 0.0 Mod Suscept.: 2.4 Least Suscept.: 14.3	High
26-2	Least Resilient: 0.0 Less Resilient: 19.0 Mod. Resilient: 5.9 Somewhat Res.: 0.0 Most Resilient: 2.9	No Data: 0.0 Most Suscept.: 23.1 Mod Suscept.: 4.7 Least Suscept.: 0.0	Most Suscept.: 0.0 Mod Suscept.: 22.0 Least Suscept.: 5.8	High
26-3	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 16.6 Somewhat Res.: 0.0 Most Resilient: 13.6	No Data: 8.0 Most Suscept.: 22.1 Mod Suscept.: 0.0 Least Suscept.: 8.1	Most Suscept.: 8.4 Mod Suscept.: 21.8 Least Suscept.: 8.0	High
26-4	Least Resilient: 0.0 Less Resilient: 2.4 Mod. Resilient: 44.7 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 20.2 Mod Suscept.: 0.0 Least Suscept.: 26.9	Most Suscept.: 27.0 Mod Suscept.: 20.1 Least Suscept.: 0.0	High
27	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 0.4 Somewhat Res.: 0.0 Most Resilient: 0.0	No Data: 0.0 Most Suscept.: 0.0 Mod Suscept.: 0.0 Least Suscept.: 0.4	Most Suscept.: 0.4 Mod Suscept.: 0.0 Least Suscept.: 0.0	High
28	Least Resilient: 0.0 Less Resilient: 0.0 Mod. Resilient: 0.0 Somewhat Res.: 0.0 Most Resilient: 2.0	No Data: 0.0 Most Suscept.: 0.4 Mod Suscept.: 1.5 Least Suscept.: 0.1	Most Suscept.: 0.2 Mod Suscept.: 1.8 Least Suscept.: 0.0	High

5.0 IMPACT METHODS

A significant step in the process of selecting a preferred route for the MSTI project is determining the initial and residual impacts. While many of the sensitive features were avoided through the regional study and associated sensitivity analysis (see MFSA Application, Vol. IV), it was not possible for alternative route links to avoid all sensitive geologic features. Consequently, it is necessary to map known sensitive geologic features within the study corridors and carry out an impacts assessment and mitigation planning procedure.

Two impact types due to geologic attributes are associated with construction and operation of transmission lines: ground disturbance and increased public access. Ground disturbance is the major impact type associated with construction and operation of transmission lines. Impacts associated with ground disturbance are those resulting from construction of spur and access roads; tower site clearing; crane pad leveling; equipment storage areas; conductor pulling and tensioning sites; and series compensation station, substation and microwave facility construction.

Impacts associated with increased public access are those related to the long-term effects of potential increased public use of remote areas that were previously inaccessible or less accessible. These impacts are generally related to erosion and removal of unique geologic features. However, given the emphasis on using existing roads where possible and incorporating sediment control and stormwater management plans in the construction, operations and maintenance of the project infrastructure, incremental increased erosion due to increased public access is judged to be insignificant. The presence the eruption features, basalt flows and flow features are the basis for designation of both Craters of the Moon National Monument and Great Rift National Natural Landmark. However, due to the lack of basalt outcrop in the vicinity of the alternative route links, the national monument and landmark, and the potential for removal of or damage to unique geologic features is judged to be low.

The following describes the methods and summarizes the results of impacts assessment and mitigation planning for sensitive geologic areas and soils. The model identified impacts resulting from ground disturbance associated with construction of the project. Construction activities were classified as temporary or permanent disturbances caused by:

- Structures
- Work areas
- Building pads
- Set-up sites
- Upgrade of existing roads
- Construction of new access roads
- Turn-around areas
- Material lay-down, storage and yarding
- New substation site in Townsend

Disturbance areas were calculated based on assumptions using GIS.

Data that were used in the model were first entered into the impact matrix. Once the matrix was constructed, the data was entered into GIS, which allowed a systematic link-by-link analysis. Output from the GIS took the form of numeric impact tables and maps that illustrate the spatial distribution of impacts on each link before and after mitigation measures were applied to each impact.

5.1 RESOURCE SENSITIVITY

In constructing the models, relevant features were identified within a one-mile impact zone on either side of the assumed centerline for each alternative route link. This included a description of geologic and erosion impacts which could potentially occur due to encountering:

- Landslides
- Liquefiable geologic units
- Active faults
- Cretaceous shales
- Intrusive rocks
- Lake-bed (lacustrine) sediments
- Lands within the Craters of the Moon National Monument and Great Rift National Natural Landmark (in Idaho)
- Highly erodible soils
- Soils with severe reclamation constraints defined as those developing on Cretaceous shales, intrusive rocks and lacustrine sediments

These occurrences were mapped and assigned a sensitivity level of high, moderate or low. Sensitivity levels were assigned based on these considerations:

- In both Montana and Idaho, known occurrences of mapped landslides, potentially liquefiable units or active faults were assumed to have high sensitivity to the project.
- Sensitivity due to the presence of Cretaceous shales, intrusive rocks and lacustrine sediments was based on access levels. Ground disturbance occurring on sloping ground was considered more sensitive than ground disturbance on level ground.
- In Idaho, sensitivity of the unique geologic features within the Craters of the Moon National Monument and Great Rift National Natural Landmark was based on access levels, with geologic features having greater sensitivity to new road construction when compared to utilizing existing roadways.

5.2 IMPACT LEVELS

5.2.1 GEOLOGY

The major potential geologic impacts to the project would occur due to construction on landslides, active faults or areas with high potential for liquefaction. Ground movement associated with these features has the potential to impact the integrity and function of the transmission line and support towers. Due to the nature of failures related to landslides, active faults or areas with high potential for liquefaction, all infrastructure related to the project including towers, lines, substations and roads were considered in the impact evaluation. Potential impact locations along alternative route links were identified by milepost. Factors considered in conducting the impacts analysis are the geologic map units and active fault locations. Mapped landslides and active faults are identified directly from the map units. Liquefiable soils are interpreted to be fine silt and sand beds located in areas of potential shallow groundwater. The shallow groundwater areas in the study area are identified as all geologic map units classified as alluvial floodplain.

Geologic hazard factors are also related to soil reclamation constraints. Soils developed on Cretaceous shales, intrusives and lacustrine sediments are more difficult to reclaim and revegetate due to their chemical composition and mechanical weathering products. Cretaceous shales and lacustrine sediments often produce highly saline soils, and intrusive rocks generally weather to granular sands with little nutrient availability.

Initial impact levels were determined by recording the presence/absence of landslides, active faults or areas with high potential for liquefaction within the links. Geology-related impacts due to Cretaceous shales, lacustrine sediments and intrusive rocks were dependant on slope and access levels.

The Environmental Protection Measures described in this report are preliminary measures that are part of the project description, but are not finalized or committed to until further discussions with the MDEQ and other agencies are conducted. Likewise, the Specifically Recommended Mitigation Measures are preliminary, and not committed to by NEW, until discussions are held on this subject with the MDEQ and other agencies.

Application of the Specifically Recommended Mitigation Measures were then evaluated to determine if projected initial impacts due to geologic features could be further reduced. Residual impacts are those estimated impacts after application of the Specifically Recommended Mitigation Measures. Initial and residual impacts are equal where no mitigation measures are proposed.

Initial impact levels relating to geologic features are defined as follows:

- **High impact** – A high impact would result if ground movement occurred due to the presence landslides or active faults. High impacts would include destabilization or toppling of towers and infrastructure failure at substations and roads. These impacts are not related to slope or access levels. With respect to reclamation and revegetation potential, high impacts would be potential substantial erosion hazard or loss of soil productivity potential.
- **Moderate impact** – No moderate impact levels were assigned to landslides, liquefaction or active faults. With respect to reclamation and revegetation potential, moderate impacts would be some erosion hazard or loss of soil productivity potential.
- **Low impact** – A low impact would result from the presence of liquefiable sediments. With respect to reclamation and revegetation potential, low impacts would be a small erosion hazard or loss of soil productivity potential.
- **No Identifiable Impact** – No identifiable impact to the MSTI infrastructure would occur in the absence of the underlying causal geologic features.

The following describes the conditions associated with estimated initial impacts:

High Impact

- Location of proposed project infrastructure on mapped landslides or active faults.
- Ground disturbance on steeply sloping terrain underlain by Cretaceous shales or intrusives. An example would be new road construction on terrain with Access Level 5 or 6 underlain by Cretaceous shales.
- High potential for landslides and reclamation constraints on terrain with Access Level 5 or 6 underlain by Cretaceous shales.

Moderate Impact

- Ground disturbance on moderately sloping terrain underlain by Cretaceous shales, intrusive or lacustrine sediments. An example would be new road construction on moderately sloping terrain with Access Level 4 on terrain underlain by Cretaceous shales, or Access Level 5 terrain underlain by intrusive rocks.
- Moderate soil erosion or productivity loss potential on terrain with Access Level 4 underlain by Cretaceous shales or Access Level 5 for terrain underlain by intrusive rocks.

Low Impact

- Ground disturbance on gently sloping terrain underlain by Cretaceous shales, intrusive rocks, or lacustrine sediments. An example would be new road construction on gently sloping terrain with Access Level 2 or 3.
- Low soil erosion or productivity loss potential on terrain underlain by Cretaceous shales, intrusive rocks, or lacustrine sediments.

5.2.2 SOILS

The primary concern in connection with soil resources is to avoid or minimize potential impacts related to wind and water erosion during and after construction. Factors considered in conducting the impacts analysis include the erosion of certain soil types, the intensity, duration and frequency of impacts, and environmental protection measures. Potential impact locations along alternative route links were identified by milepost.

Ground disturbance levels were estimated by considering the slope and amount of disturbance related to construction activities. Initial impact levels were estimated by combining projected ground disturbance level, soil characteristics (i.e., T, Kw and WEG), and environmental protection measures. Application of Specifically Recommended Mitigation Measures was then evaluated to determine if projected initial impacts to soil resources could be further reduced. Residual impacts are those estimated impacts remaining after application of the Specifically Recommended Mitigation Measures. See Volume I of the MFSA application, Section 2.6 for this list of Environmental Protection Measures and Specifically Recommended Mitigation Measures.

Impact levels relating to soils are defined as follows:

- **High impact** – a high level of impact to soil resources would result if the construction, operation, maintenance or abandonment of the MSTI project would potentially cause a substantial erosion hazard or loss of soil productivity potential.
- **Moderate impact** – a moderate level of impact to soil resources would result if the construction, operation, maintenance or abandonment of the MSTI project would potentially cause some erosion hazard or loss of soil productivity potential.
- **Low impact** – a high level of impact to soil resources would result if the construction, operation, maintenance or abandonment of the MSTI project would potentially cause a small erosion hazard or loss of soil productivity potential.
- **No Identifiable Impact** – no identifiable impact to soil resources would be identified where no loss of soil or loss of productive potential would occur.

All soil units affected by the MSTI project would be subject to some level and type of disturbance. Soil surface disturbance, compaction and erosion would occur to varying degrees. These disturbances would likely result in some increase to wind and water erosion rates and loss of productivity levels, and lead to a loss of soil resources.

Direct impacts to soil resources would result from construction activities. Construction activities were classified as temporary and permanent disturbances caused by:

- Structures
- Work areas
- Building pads
- Set-up sites
- Upgrade of existing roads
- Construction of new access roads
- Turn-around areas
- Material lay-down, storage and yarding
- New substation site in Townsend

The following describes the conditions associated with estimated initial impact levels:

High Impact

- Construction activities in steep terrain. An example would be new road construction in sloping terrain with Access Level 5 or 6.
- High soil erosion or productivity loss potential.

Moderate Impact

- Construction activities in flat to moderately sloping terrain. An example would be new road construction on gently sloping terrain with Access Level 3 or 4.
- Moderate soil erosion or productivity loss potential.

Low Impact

- Ancillary activities related to construction. An example would be using unimproved roads existing roads or overland travel in agricultural areas.
- Low soil erosion or productivity loss potential.

6.0 IMPACT RESULTS

The results of the impact analysis for soils and geology were generated by first identifying the geologic or soils attribute, estimating the initial impact, identifying a specifically recommended mitigation measure to reduce or eliminate the initial impact, and estimating the residual impact after application of the Specifically Recommended Mitigation Measures. It should be noted that environmental protection measures have been developed as part of the project description (see Chapter 2, Vol. I, MFSA Application), and the initial impact estimate accounts for the anticipated reduction of potential impact that has occurred as a result of the implementation of the environmental protection measures.

To minimize potential structural failure of the transmission towers due to ground rupture or landslides, a reconnaissance–level field mapping effort is recommended as part of project planning and construction. The geologic mapping would identify the location of active faults and landslides shown on the source maps used for the Technical Report (see MFSA Application, Volume I). Appropriate set-backs from all mapped faults would be established for all project related structures. The landslide maps would include figures showing the aerial extent of the landslides, and a description of the landslide geology, surface features, and hydrogeology. Where possible, structures and roads would avoid landslide areas. Where not possible to avoid disturbance on landslide areas, all roads and structures would be designed with appropriate measures to minimize engineering risk.

With the performance of pre-construction geological investigations, it is anticipated there would be no alternate route links with moderate or high initial impacts. Where initial impacts are low, no additional mitigation is necessary.

6.1 GEOLOGY

A summary of the geologic results is included in Appendix A, Table A-3. From the perspective of assessing impacts, all the features except faults and sensitive geologic features inside national landmarks and national monuments are access-level dependant. Only the links with access levels that drive initial impacts to moderate or high factored into the total mileage in the summary table. An example of this rating system would be intrusive rock. Only intrusive rock occurring in links with access levels 5 and 6 are listed in the summary table below. Active faults and features inside national landmarks and national monuments are associated with high initial impacts regardless of access level.

Note that in Link 16.2 a fault trace is identified on maps generated for this project that is parallel but not crossing the proposed transmission line footprint. Since the fault is not depicted crossing the link in this study, no faults are listed in Table A-1 (Appendix A). Although the fault is not shown intercepting the footprint, the accuracy in fault placement on the map and scale factors suggest that the fault could possibly be directly beneath or across the footprint in the 2.3 miles of Link 16-2 from MP 21.7 to 24.0.

6.2 SOILS

A summary of the soil results is included in Appendix A, Table A-4. Analysis of the soil impact data indicate that high initial impacts always result from new road construction in soils rated with high sensitivity characteristics as described in Section 4.2. High sensitivity characteristics are: (1) soil productivity (T) factors rated Least or Less Resilient; (2) water erodibility (Kw) factors rated as Most Susceptible; and (3) wind erodibility group (WEG) factors rated as Most Susceptible.

It should be noted that new road construction in more durable soils does not result in high initial impacts. Soil units with moderate to low sensitivity as defined in Section 4.2 are less susceptible to erosion from wind and water, and are more tolerant of disturbance.

7.0 REFERENCES

Gillerman, V. 2008. Research Geologist, Idaho Geologic Survey, personal communication.

Hoover, D. 2008. Senior Soil Scientist, National Resource Conservation Service Boise Regional Office, personal communication.

Kellogg, K. S. and V.S. Williams. 2005. Geologic Map of the Ennis 30' x 60' Quadrangle, Madison and Gallatin Counties, Montana and Park County, Wyoming; Montana Bureau of Mines and Geology Open File Report 529, 1:100,000 scale.

Kuntz, M.A., J.K. Geslin, L.E. Mark, M.K.V. Hodges, M.E. Kauffman, D.E. Champion, M.R. Lanphere, D.W. Rodgers, M.H. Anders, P.K. Link and D.L. Boyack. 2003. Geologic Map of the Northern and Central Parts of the Idaho National Engineering and Environmental Laboratory, Eastern Idaho: Idaho Geological Survey, Geologic Map GM-35, scale 1:50000.

Kuntz, M.A., B. Skipp, M.A. Lanphere, W.E. Scott, K.L. Pierce, G.B. Dalrymple, D.E. Champion, G.F. Embree, W.R. Page, L.A. Morgan, R.P. Smith and D.W. Rodgers. 1994. Geologic Map of the Idaho National Engineering Laboratory and Adjoining Areas, Eastern Idaho, U. S. Geological Survey, Miscellaneous Investigations Map I-2330, 1:100,000 scale.

Kuntz, M.A., B. Skipp, D.E. Champion, P.B. Gans, D.P. Van Sistine and S.R. Snyders. 2007. Geologic Map of the Craters of the Moon 30' x 60' Quadrangle, Idaho; U. S. Geological Survey Scientific Investigations Map SIM-2969, 1:100,000 scale.

Lewis, R. S. 1998. Geologic Map of the Butte 1º x 2º Quadrangle, South-Western Montana, Montana Bureau of Mines and Geology Open File No. 363, 1:250,000 scale.

Link, P.S., and Stanford. 1999. Geologic Map Compilation of the Pocatello 30' x 60' Quadrangle, Idaho, Idaho Geologic Survey, Technical Report T-99-2, 1:100,000 scale.

Lonn, J.D. 2008. Assistant Research Geologist, Montana Bureau of Mines and Geology, personal communication.

Lonn, J.D., B. Skipp, E.T. Ruppel, S.U. Janecke, W.J. Perry, Jr., J.W. Sears, M.J. Bartholomew, M.C. Stickney, H.A. Hurlow and R.G. Thomas. 2000. Preliminary Map of the 30' x 60' Lima Quadrangle, Southwest Montana; Montana Bureau of Mines and Geology Open File No. 408, 1:100,000 scale.

Montana Department of Environmental Quality. 2004. Major Facility Siting Act Circular MFSA-2, Application Requirements for Linear Facilities.

National Resource Conservation Service. 2008. State Soil Geographic Database (STATSGO), http://soildatamart.nrcs.usda.gov/

Rember, W. C., and E.H. Bennett. 1979. Geologic Map of the Dubois 30' by 60' Quadrangle, Idaho, Idaho Geologic Survey, Geologic Map Series GM-7, 1:250,000 scale.

Rember, W. C., and E.H. Bennett. 1979. Geologic Map of the Idaho Falls 30' by 60' Quadrangle, Idaho, Idaho Geologic Survey, Geologic Map Series GM-12, 1:250,000 scale.

Reynolds, M. W., and T.R. Brandt. 2006. Preliminary Geologic Map of the Townsend 30' x 60' Quadrangle, Montana; U. S. Geologic Survey Open File Report 2006-1138, 1:100,000 scale.

Ruppel, E. T. 1998. Geologic Map of the Eastern Part of Leadore 30' x 60' Quadrangle, Montana and Idaho, Montana Bureau of Mines and Geology Open File No. 372, 1:100,000 scale.

Ruppel, E. T., J.M. O'Neill and D.A. Lopez. 1993. Geologic Map of the Dillon 1º x 2º Quadrangle, Montana and Idaho, U. S. Geological Survey Geologic Investigations Series I-1803, 1:250,000 scale.

U.S Bureau of Land Management. 2007. Management Plan for Craters of the Moon National Monument and Preserve, Shoshone Field Office, Shoshone, Idaho.

U.S. Geologic Survey. 2008. U.S. Quaternary fault and fold database, website URL http://earthquake.usgs.gov/regional/qfaults/usmap.php.

Vuke, S. 2008. Associate Research Geologist, Montana Bureau of Mines and Geology, personal communication.

Vuke, S., J.D. Lonn, R.B. Berg, R. B. and K.S. Kellogg. 2002. Preliminary Geologic Map of the Bozeman 30' x 60' Quadrangle, Southwestern Montana, 2002, revised January 2003, MBMG Open File 469, 1:100,000 scale.

Wilde, E.M., K.L. Sandau, P.J. Kennelly and D.A. Lopes. 2002. Compilation of Landslide location Maps and Index for Identification of Slide-Prone Areas: A Pilot Study for the Butte District, Montana Bureau of Mines and Geology Publication 472.

APPENDIX A

Table A-1	Geologic Inventory Results
Table A-2A	Soil Resilience Rating
Table A-2B	Water Erosion Rating
Table A-2C	Wind Erodibility Group Ratings
Table A-3	Geologic Hazards Result Summary
Table A-4	Soil Results Summary